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2018 SPRING ACOUSTIC AUDIT - IMMISSION REPORT

McLean's Mountain Wind Project

Manitoulin Island, Ontario

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Ian R. Bonsma, PEng

July 26, 2018

VERSION CONTROL

McLean's Mountain Wind Power Project
2018 Spring Acoustic Audit - Immission Report

Version	Date	Version Description
1	July 26, 2018	Original Report

EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by McLean's Mountain Wind Limited Partnership to complete an Immission Audit of the McLean's Mountain Wind Project ("Wind Project") in the Municipality of Central Manitoulin. The project includes 21 General Electric GE 2.49-103, 2 General Electric GE 2.66-103 and 1 General Electric GE 2.38-103 wind turbine generators, rated at 2.49, 2.66 and 2.38 MW, respectively. The Immission Audit is required as a condition of Renewable Energy Approval number 7733-8XUNS5 issued to McLean's Mountain Wind Limited Partnership by the Ontario Ministry of the Environment, Conservation and Parks ("MOECP"). HGC Engineering has assessed the acoustic impact against the acoustic criteria of the MOECP and in accordance with the requirements of the MOECP's *Compliance Protocol for Wind Turbine Noise*. This report presents the results from the spring measurement campaign, completed between March 28 and June 13, 2018. The sound level measurements and analysis, as performed in accordance with the MOECP's *Compliance Protocol for Wind Turbine Noise*, indicate that the Wind Project meets the applicable sound level limits at the selected monitoring locations. Details of the measurements and analysis are provided herein.

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1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by McLean's Mountain Wind Limited Partnership to complete an Acoustic Audit – Immission of the McLean's Mountain Wind Project ("Wind Project"). The Wind Project is located in the Municipality of Central Manitoulin, Ontario and consists of 21 General Electric GE 2.49-103, 2 General Electric GE 2.66-103 and 1 General Electric GE 2.38-103 wind turbine generators, rated at 2.49, 2.66 and 2.38 MW, respectively, and with 98 m hub heights.

The Audit is required as part of the Renewable Energy Approval ("REA") number 7733-8XUNS5 [1] issued to McLean's Mountain Wind Limited Partnership by the Ontario Ministry of the Environment, Conservation and Parks ("MOECP"). Specifically, this report summarizes the spring measurements that were conducted in order to satisfy one of the two audits required under Condition E of the REA.

Although a previous measurement campaign was conducted in the spring of 2014, a complete data set was not collected at receptors PR289 and VP019 because of low winds. Thus, a letter sent from Northland Power to the MOECP, dated August 18, 2017, stated that a new spring Immission Audit would take place under the new 2017 *Compliance Protocol for Wind Turbine Noise – Guidelines for Acoustic Assessment and Measurement* ("Compliance Protocol") [2] at the earliest opportunity. The Immission Audit detailed in this report satisfies the spring requirement for receptors PR289 and VP019.

2 MONITORING LOCATIONS

The Environmental Noise Impact Assessment ("ENIA") [3] prepared by Aercoustics provided sound level predictions for receptors within 1500 m of the project wind turbine generators. The receptor locations selected for the Immission Audit (PR289, VP019) satisfy the two requirements of the REA:

- The receptors should represent the location of the greatest predicted noise impact.
- The receptors should be in the direction of prevailing winds from the facility.

A summary of the monitoring location selection and the historical wind rose for the area can be found in Appendix A. Predicted sound levels for the receptors surrounding the Wind Project were taken from the ENIA.

The monitoring locations were selected based on their downwind location, predicted sound level, and consultation with the land owners. Detailed overviews of the selected monitoring locations are shown in Figure 1 and photos of the installations are provided in Appendix B.

HGC Engineering developed an acoustic predictive model of the site to determine the sound levels at the two selected monitoring and receptor locations. The predicted sound levels at the receptor and monitoring locations, along with their respective UTM coordinates can be found in Table 1.

Table 1: Predicted Sound Levels and UTM Coordinates of Selected Locations

Location		Easting	Northing	Predicted Sound Level [dBA]
VP019	Receptor	426807	5089032	38.0[±]
	Monitoring Location M1	426705	5089074	38.1[*]
PR289	Receptor	423357	5087054	38.8[±]
	Monitoring Location M2	423259	5087078	38.4[*]

[±] Sound level taken from ENIA [3]
[*] Sound level predicted by acoustic model created by HGC Engineering

Based on the ENIA, the predicted sound levels at the monitoring locations are 38.0 dBA and 38.8 dBA at locations VP019 and PR289 respectively. Receptor VP019, is a participating vacant lot located on the north-east side of the project with the closest turbine, T09, approximately 700 metres south. This location conservatively represents the non-participating vacant lot V239 and additional receptors to the north. Receptor PR289 is a single storey home with the closest turbine, T11, approximately 670 metres north. This location conservatively represents the non-participating receptor R282.

The Wind Project area is generally rural in nature with infrequently travelled gravel roads.

3 INSTRUMENTATION

The Compliance Protocol provides instrumentation requirements for Acoustical Audits of wind energy projects. The instrumentation used for this acoustic audit satisfies the requirements of the Compliance Protocol.

Audio frequency sound levels were measured using Svantek 977 sound level meters, each connected to ½" microphones. The microphones were set at a height of approximately 4.5 m and equipped with 175 mm diameter windscreens to minimize wind-induced microphone self-noise.

The energy-equivalent average sound level, denoted L_{EQ}, was recorded by the instrumentation. The audio-frequency measurements are presented as A-weighted sound levels as they are intended to represent the loudness of sounds as perceived by the human ear. The overall audio-frequency sound level monitoring results are summarized in this report.

In addition to the acoustic instrumentation, meteorological instruments were used. A Davis weather station was deployed at Monitoring Location M1 to collect ground weather conditions including temperature, humidity, and precipitation. NRG anemometers and wind vanes were used at each receptor location to collect 10 m height wind speed and direction.

The various instruments deployed by HGC Engineering are summarized in Table 2, and their respective locations are shown in Figures 1a and 1b.

Table 2: Measurement Instrumentation

Location	Instrumentation Make and Model	Serial Number
M1 (VP019)	Svantek 977 sound level meter	45419
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500245122
M2 (PR289)	Svantek 977 sound level meter	45420
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500244813

The sound level meters were configured to measure and record spectral (frequency-dependent) one-minute L_{EQ} sound level measurements. For identification of dominant sources, the sound level meters also recorded audio files.

Correct calibration of the acoustic instrumentation was verified using an acoustic calibrator manufactured by Brüel & Kjær (B&K). Calibration verification was carried out on a bi-weekly basis throughout the measurement period.

Windscreens were used on the microphones, consistent with the requirements of MOECP technical publication *NPC-103, Procedures* [4]. A large wind screen, 175 mm in diameter, was used on each sound level meter to minimize wind-induced microphone self-noise at higher wind speeds. Sound level data included herein has not been adjusted for the sound insertion loss of the large wind screen.

All the equipment was within its annual or bi-annual calibration, confirmed by the calibration certificates found in Appendix C.

4 ASSESSMENT CRITERIA

The MOECP publication *Noise Guidelines for Wind Farms – Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities* [5] indicates the applicable sound level limit for wind energy projects in a Class 3 environment. Additionally, the Compliance Protocol includes the same sound level limits which are shown in Table 3.

Table 3: Wind Turbine Noise Criteria [dBA]

10 m Height Wind Speed [m/s]	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 2 Area [dBA]	40.0	40.0	40.0	43.0	45.0	49.0	51.0

It should be noted that the sound level limits of the MOECP apply only to the sound level contribution of the sound source under assessment, in this case the sound from the wind turbine generators. Thus, where a sound level measured at a receptor location includes significant sound due to the relevant sound source and unrelated background sound sources (i.e., road vehicles, trains, air traffic, farming machinery, wind, etc.), some form of evaluation must be made to

determine the sound level contribution of the source under assessment in the absence of the background sounds. Methodology prescribed by the MOECP to complete an assessment of a wind energy project is discussed in the following section.

5 METHODOLOGY

The MOECP requested the acoustic audit be completed in accordance with Part D of the 2017 Compliance Protocol. Part D includes requirements for instrumentation, measurement, and data reduction procedures to assist with determining compliance.

A series of one-minute energy-equivalent sound level measurements are collected with ("ON") and without ("OFF") the turbines operating. Simultaneously, wind speed and direction at 10 m height are measured and collected in one-minute intervals. The measured sound level data is separated into integer wind speed "bins" where the sound levels corresponding to each integer wind speed are logarithmically averaged to determine the average sound level when the wind turbines are operational and when they are parked. The ambient L_{EQ} (turbines parked) is logarithmically subtracted from the overall L_{EQ} (turbines operational) to determine the sound level contribution of the wind turbines alone. Supplementary data including wind speed at turbine hub height, wind speed at noise measurement height, turbine electrical power output, turbine yaw position, temperature, humidity, and statistical noise indices (Ln) can also be measured during the monitoring campaign to aid in the analysis.

Part D of the Compliance Protocol requires at least 120 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbines are operating and at least 60 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbines are parked. Prior to determining the number of data points measured in each wind speed bin, the data is filtered to only include night-time hours (between 22:00 and 05:00) and data outside of rainfall (no rain within one hour of the measurement interval). Data is also filtered to only include periods where the closest turbine is operating at greater or equal to 85% of its rated electrical power output and at least 90% of its maximum sound power, and the turbine yaw position is +/-45 degrees from the line of sight between the closest turbine and the measurement location (measurement location is downwind).

In order to maximize the number of valid data points, a modified electrical power filter was used in the analysis. The modified power filter was calculated using a conservative estimate of the turbine's electrical power output at 90% of maximum sound power, using data from the manufacturer, General Electric. Detailed calculations of the modified power filter are available in Appendix D.

If the measurement campaign does not yield sufficient data to satisfy the minimum requirements of Part D of the Compliance Protocol, a Revised Assessment Methodology Immission Audit can be completed. As described in Part E5.5 of the Compliance Protocol, three wind speed bins between 1 and 7 m/s or two wind speed bins between 1 and 4 m/s are required. With appropriate justification, the number of one-minute intervals required in each bin may be reduced to 60 for turbine operational measurements (ON) and 30 for ambient measurements (OFF). If there is insufficient ambient sound level data (OFF), a value of 30 dBA or data from a lower wind speed bin may be used to represent the ambient sound level at higher wind speed bins.

The Compliance Protocol allows for the removal of individual events to improve the signal to noise ratio. A review of the audio recordings allows for the identification of the dominant noise source within a given one-minute interval, and the subsequent removal of data points that contain interference.

Adjustments to the measured sound levels may be required based on wind turbine tonality, if any. If during the acoustic measurement campaign the project wind turbines exhibit tonal characteristics (a whine, screech, buzz or hum) then an assessment of the tonal audibility is required according to the CAN/CSA publication *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques* [6]. The average tonal audibility correction must be determined for each integer wind speed and the correction added to the final noise contribution of the Wind Project at those wind speeds, in accordance with International Standards Organization *1996-2* [7].

6 TONALITY ASSESSMENT

Based on our site observations up close to the wind turbine generators and review of the audio recordings there were no tones identified/observed at the turbines or the monitoring locations.

7 MEASUREMENTS AND RESULTS

Sound level measurements were conducted between March 28 and June 13, 2018. The weather during the monitoring period varied, including several days with rain. Temperatures ranged from -15 to 26°C. Wind speeds at 10 m height ranged from 0 m/s up to 15 m/s. The prevailing wind direction during the measurement campaign was from the northwest and northeast, inconsistent with the historical wind rose, which shows wind predominantly from the west and southwest. Figures 2a through 3b show the wind roses for the monitoring locations during the ON and OFF conditions.

The sound level summary for data collected at Monitoring Location M1 is shown in Tables 4a and 4b. Data were collected between March 28 and June 13, 2018.

Table 4a: Monitoring Location M1 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]				
Wind Project Condition	**3**	**4**	**5**	**6**	**7**
Operating (ON)	15[1]	63	87	345	205
Ambient (OFF)	414	360	204	143	78

[1] Less than 60 data points for Operating (ON) Condition

Table 4b: Monitoring Location M1 - Sound Level Summary

	10 m Height Wind Speed [m/s]									
L_{EQ} Sound Level [dBA]	**3**		**4**		**5**		**6**		**7**	
Average Operating (ON) / Std Dev.	-[1]		41	2.1	42	2.0	41	1.3	43	1.9
Average Ambient (OFF) / Std Dev.	28	3.3	33	2.8	38	4.1	43	2.5	47	2.2
Wind Project Only	-		40		39		-		-	
Criteria	40.0		40.0		40.0		40.0		43.0	
Excess	-		**0**		**0**		**0**		**0**	

[1] Less than 60 data points for Operating (ON) Condition

Based on the data presented above, and in Figures 4a and 4b, the Wind Project is compliant with the MOECP's sound level criteria at Monitoring Location M1.

The sound level summary for data collected at Monitoring Location M2 is shown in Tables 5a and 5b. Data were collected between March 28 and June 13, 2018.

Table 5a: Monitoring Location M2 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]				
Wind Project Condition	**1**	**2**	**3**	**4**	**5**
Operating (ON)	0	4	63	100	60
Ambient (OFF)	482	413	180	191	54

[1] Less than 60 data points for Operating (ON) Condition or 30 data point for Ambient (OFF) condition

Table 5b: Monitoring Location M2 - Sound Level Summary

	10 m Height Wind Speed [m/s]									
L_{EQ} Sound Level [dBA]	**1**		**2**		**3**		**4**		**5**	
Average Operating (ON) / Std Dev.	-		-		38	1.1	40	1.2	42	1.7
Average Ambient (OFF) / Std Dev.	25	3.7	26	3.7	32	2.5	34	2.2	38	2.8
Wind Project Only	-		-		37		39		40	
Criteria	40.0		40.0		40.0		40.0		40.0	
Excess	-		-		0		0		0	

[1] Less than 60 data points for Operating (ON) Condition or 30 data point for Ambient (OFF) condition

Based on the data presented above, and in Figures 5a and 5b, the Wind Project is compliant with the MOECP's sound level criteria at Monitoring Location M2.

Appendix E includes a statement from the Wind Project indicating the wind turbine generators were operating normally from March 28 to June 13, 2018.

8 CONCLUSIONS

The measurements and analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment, Conservation and Parks' 2017 publication *Compliance Protocol for Wind Turbine Noise* indicate that the McLean's Mountain Wind Project is operating in compliance with the MOECP's sound level criteria at monitoring locations M1 and M2.

REFERENCES

1. Ontario Ministry of the Environment, Conservation and Parks, Renewable Energy Approval Number 7733-8XUNS5, October 31, 2013.
2. Ontario Ministry of the Environment, Conservation and Parks, *Compliance Protocol for Wind Turbine Noise Guideline for Acoustic Assessment and Measurement*, April 2017.
3. Aercoustics Engineering Ltd., *McLean's Mountain Wind Farm Environmental Noise Impact Assessment*, May 3, 2013.
4. Ontario Ministry of the Environment, Conservation and Parks Publication, NPC-103, *Procedures.*
5. Ontario Ministry of the Environment, Conservation and Parks Publication, *Noise Guidelines for Wind Farms*, May 2016.
6. CAN/CSA-C61400-11:07, *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques*, October, 2007
7. International Standards Organization 1996-2, *Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels*, 2007.
8. Government of Canada, *Canadian Wind Energy Atlas*, Retrieved from http://www.windatlas.ca/rose-en.php?field=EU&height=30&season=ANU&no=24&postal=p0p1k0 on June 28, 2018.

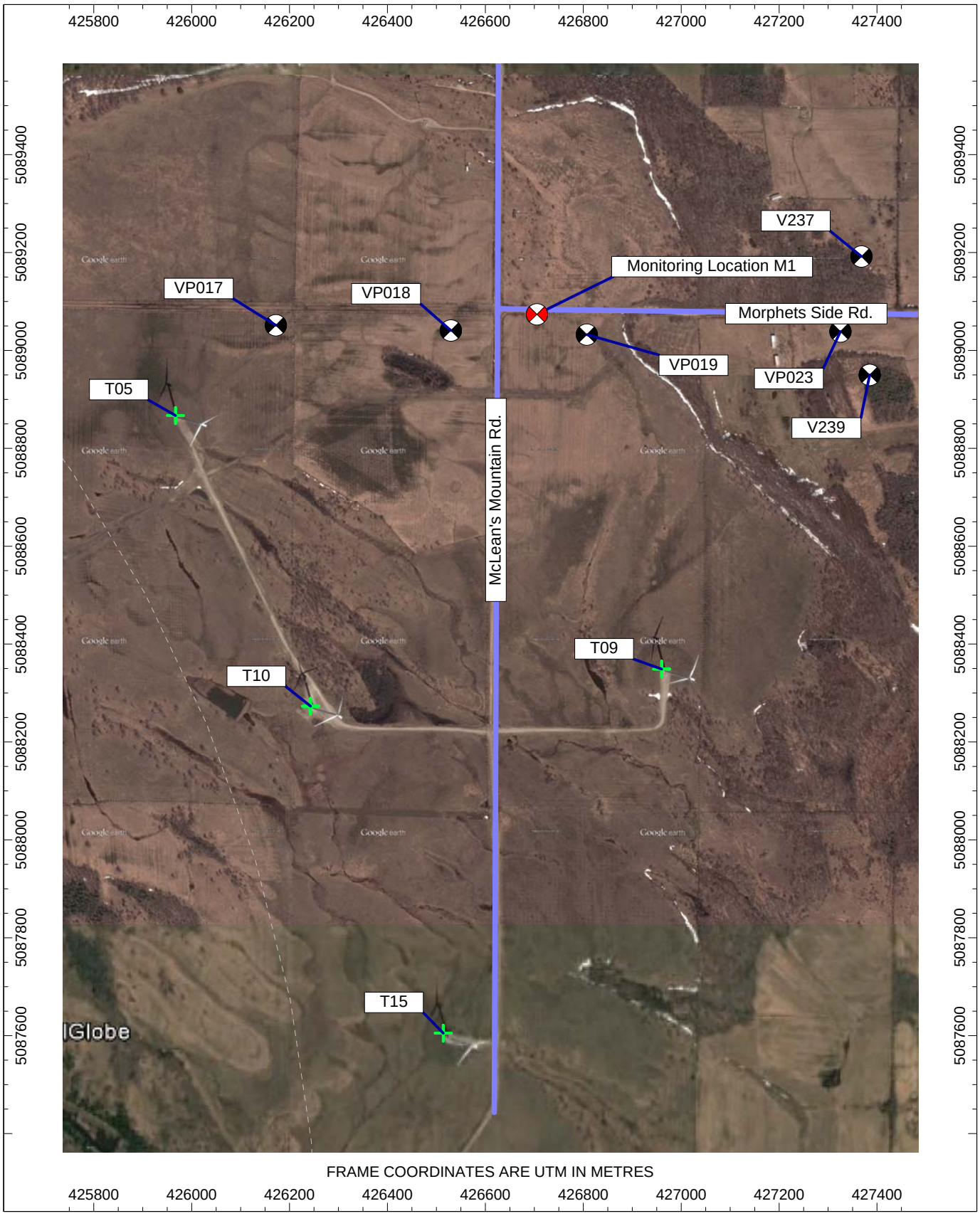


Figure 1a: Location of Receptor VP019 and Monitoring Location M1

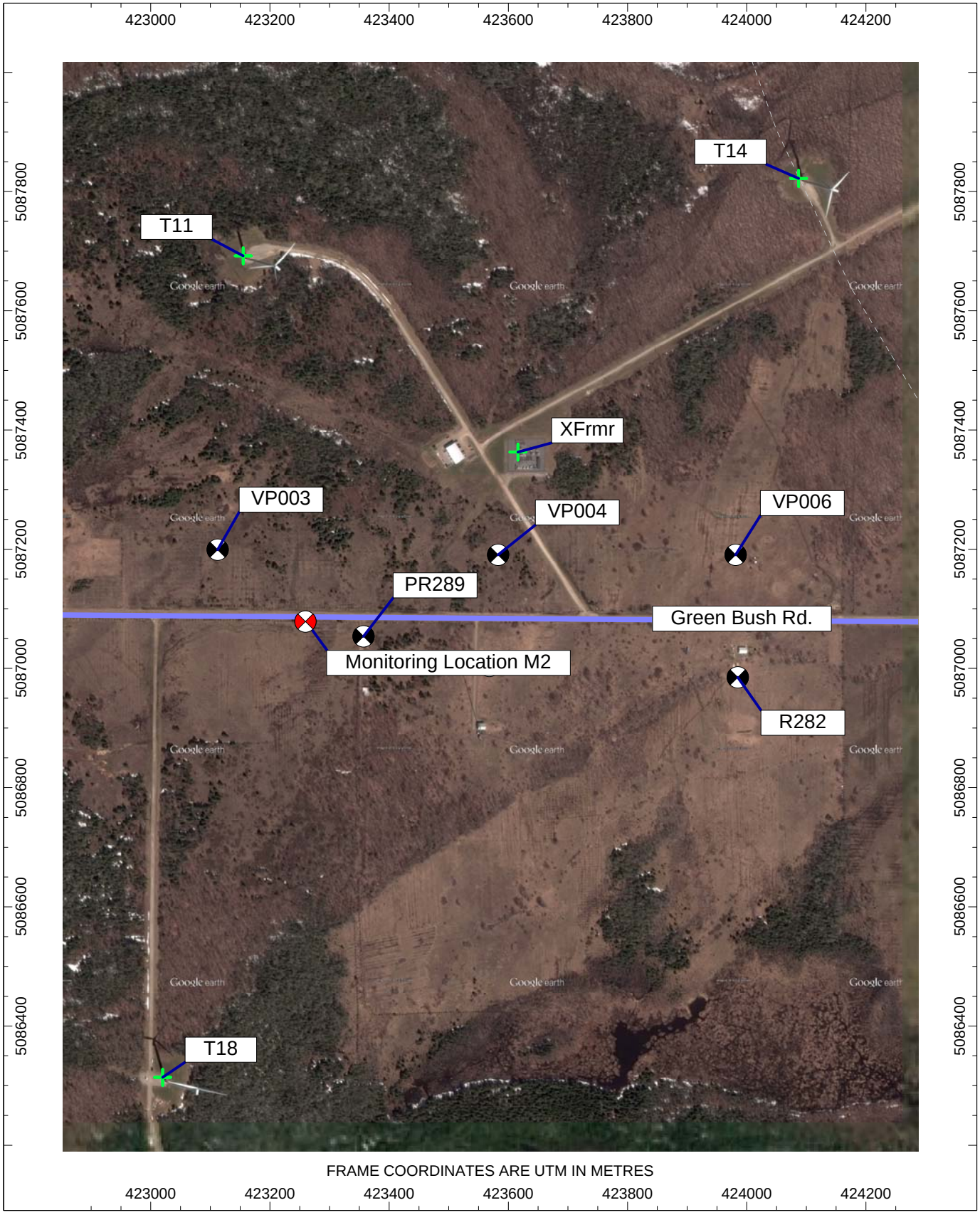


Figure 1b: Location of Receptor PR289 and Monitoring Location M2

Figure 2a: Wind Direction - McLean's Mountain Wind Project

Monitoring Location M1, 10 m Height, ON Condition - March 28 to June 13, 2018

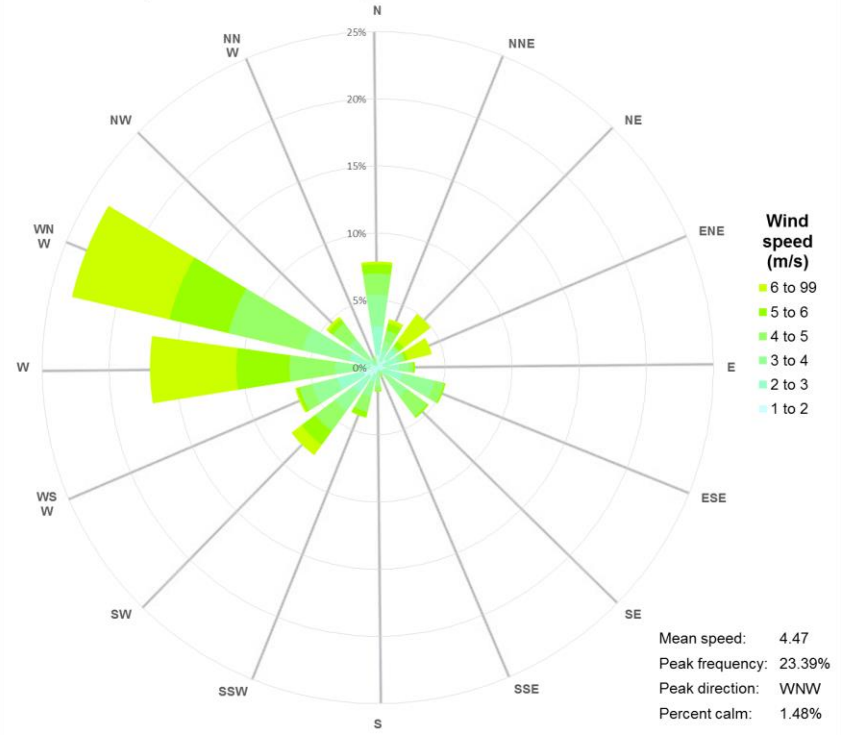


Figure 2b: Wind Direction - McLean's Mountain Wind Project

Monitoring Location M1, 10 m Height, OFF Condition - March 28 to June 13, 2018

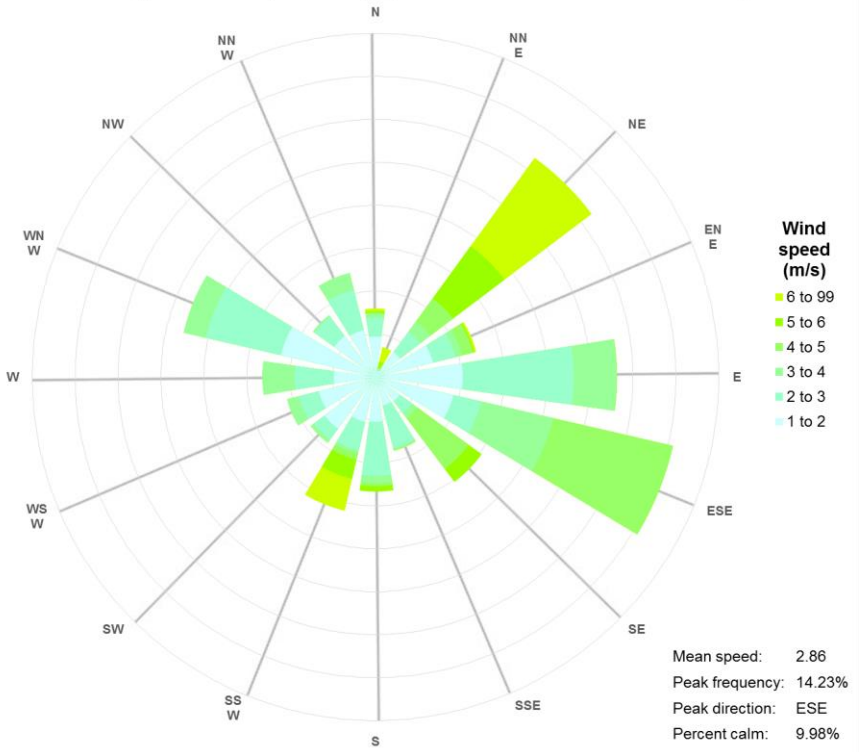


Figure 3a: Wind Direction - McLean's Mountain Wind Project

Monitoring Location M2, 10 m Height, ON Condition - March 28 to June 13, 2018

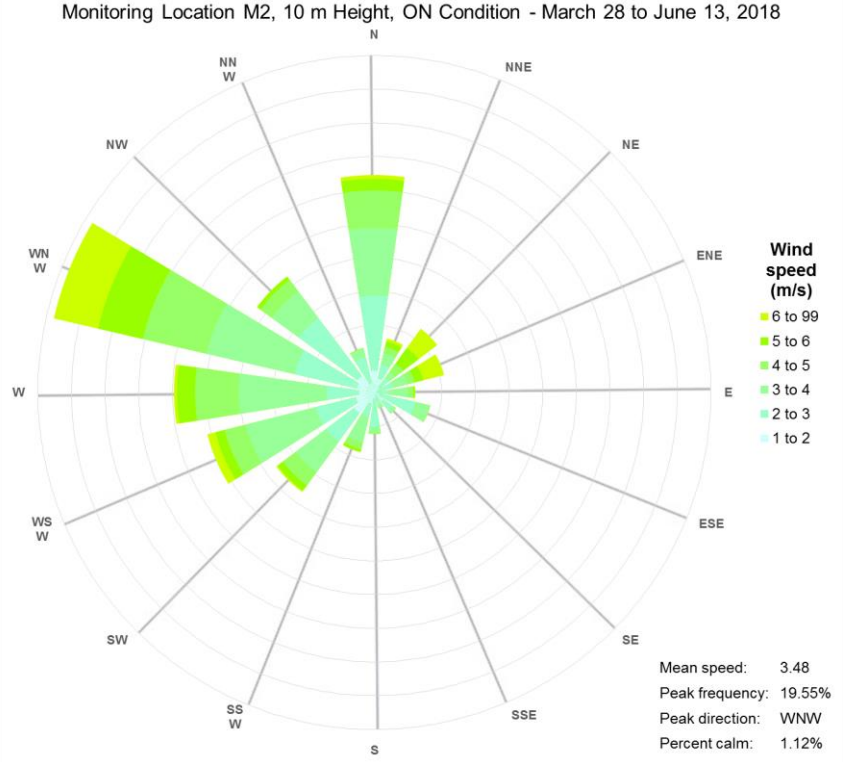


Figure 3b: Wind Direction - McLean's Mountain Wind Project

Monitoring Location M2, 10 m Height, OFF Condition - March 28 to June 13, 2018

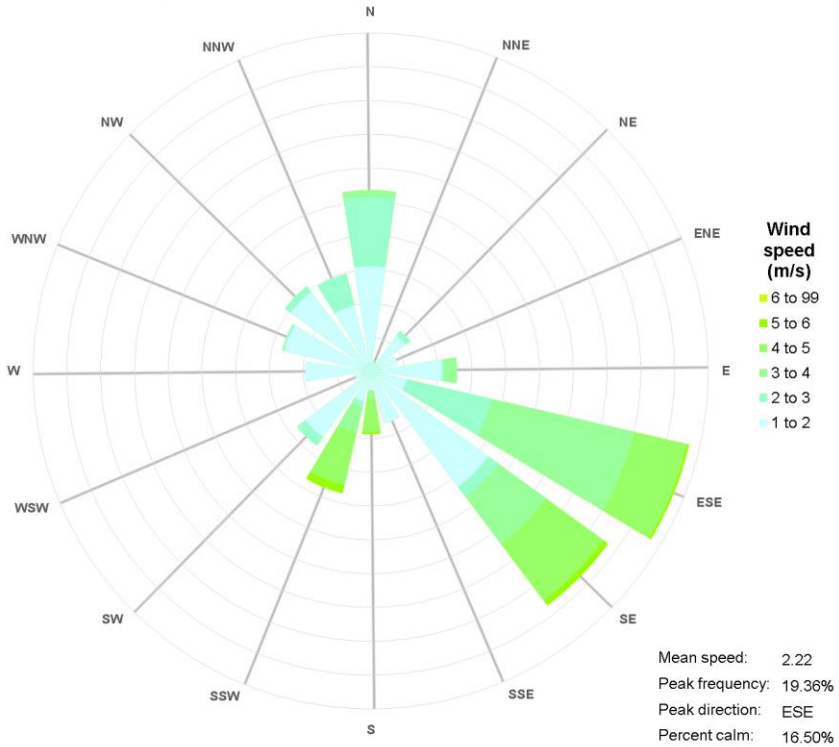


Figure 4a: McLean's Mountain Wind Project, Immission Results
Monitoring Location M1, March 28 to June 13, 2018

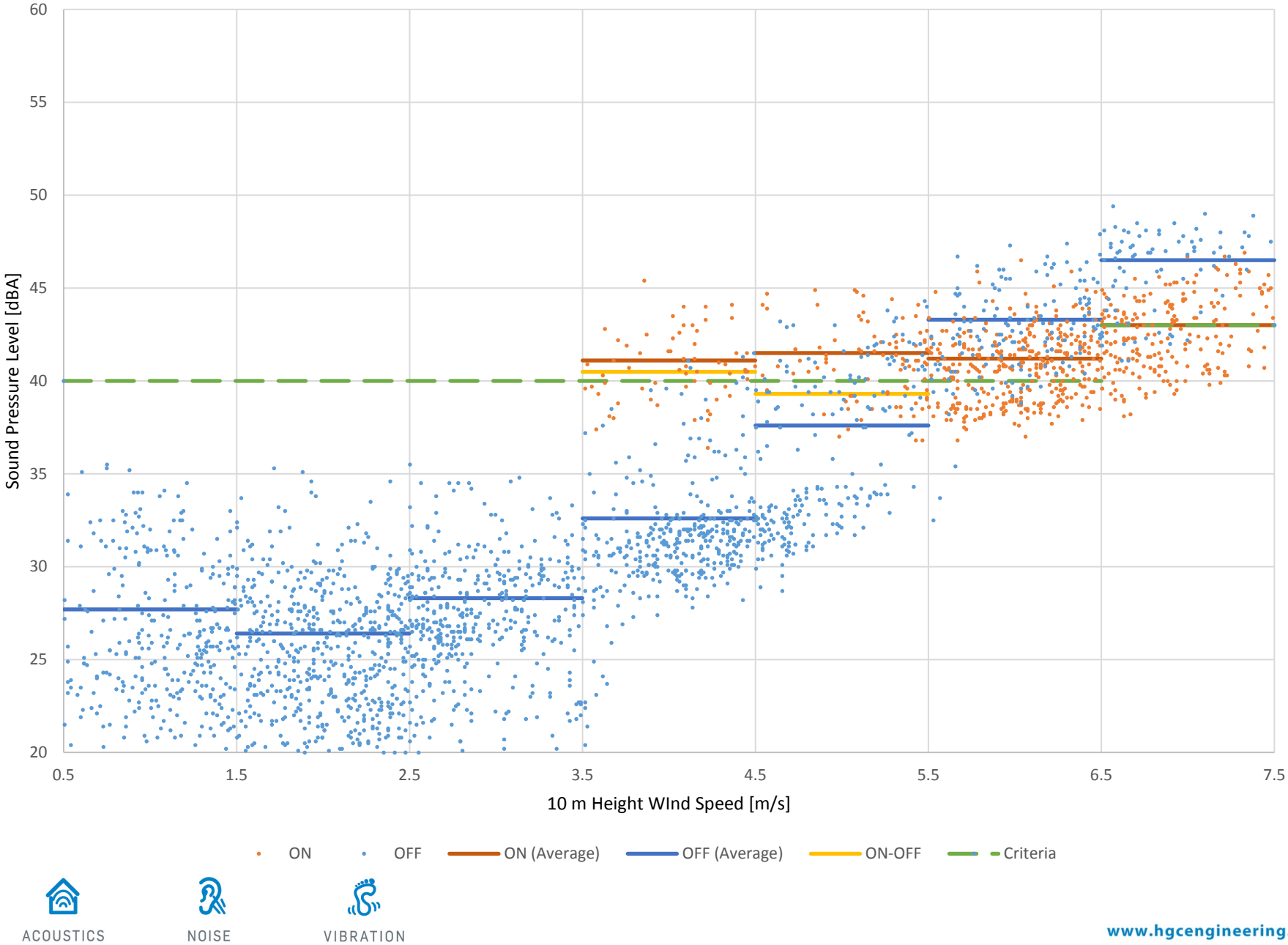


Figure 4b: McLean's Mountain Wind Project, Immission Results
Monitoring Location M1, March 28 to June 13, 2018

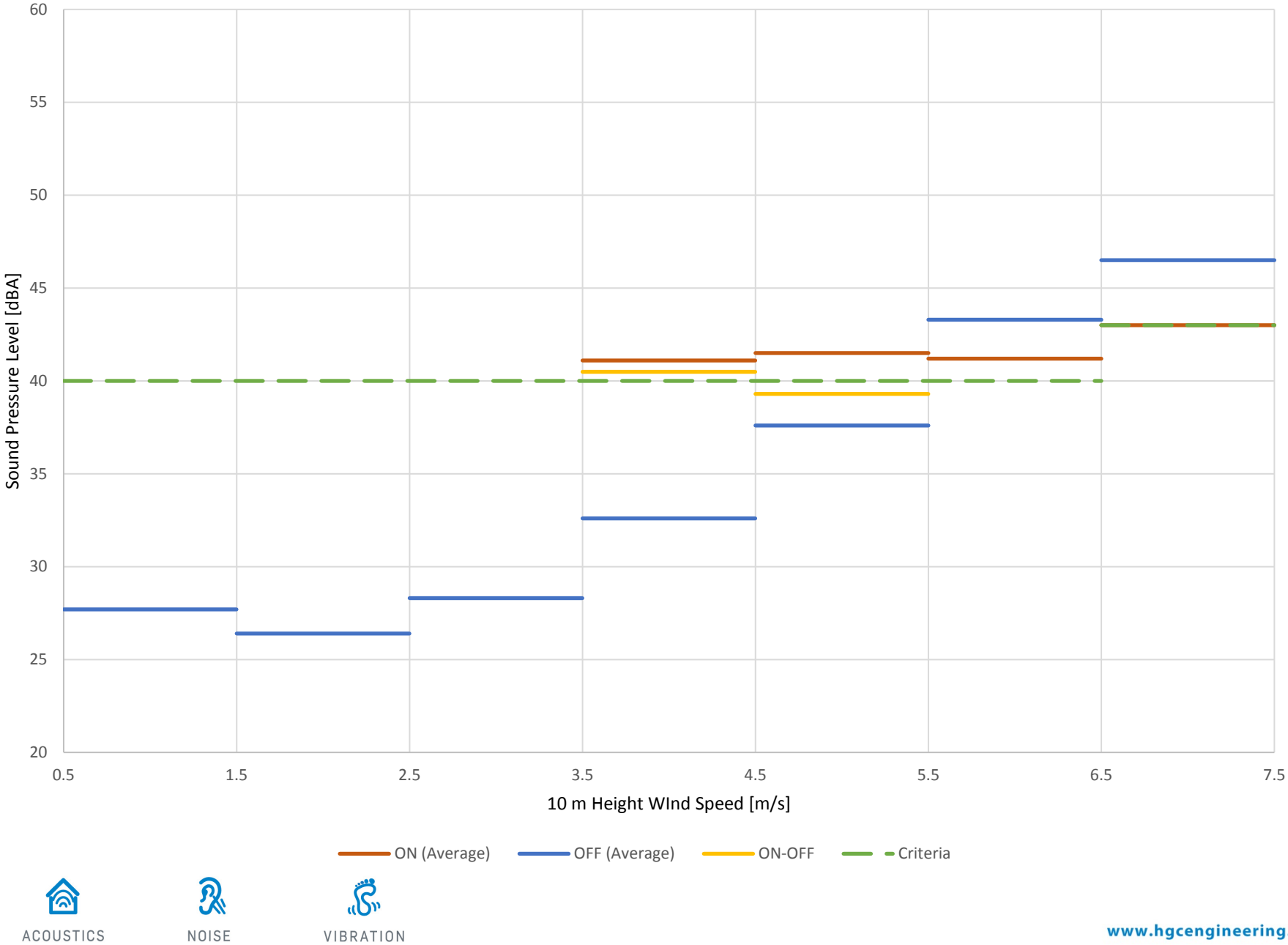


Figure 5a: McLean's Mountain Wind Project, Immission Results
Monitoring Location M2, March 28 to June 13, 2018

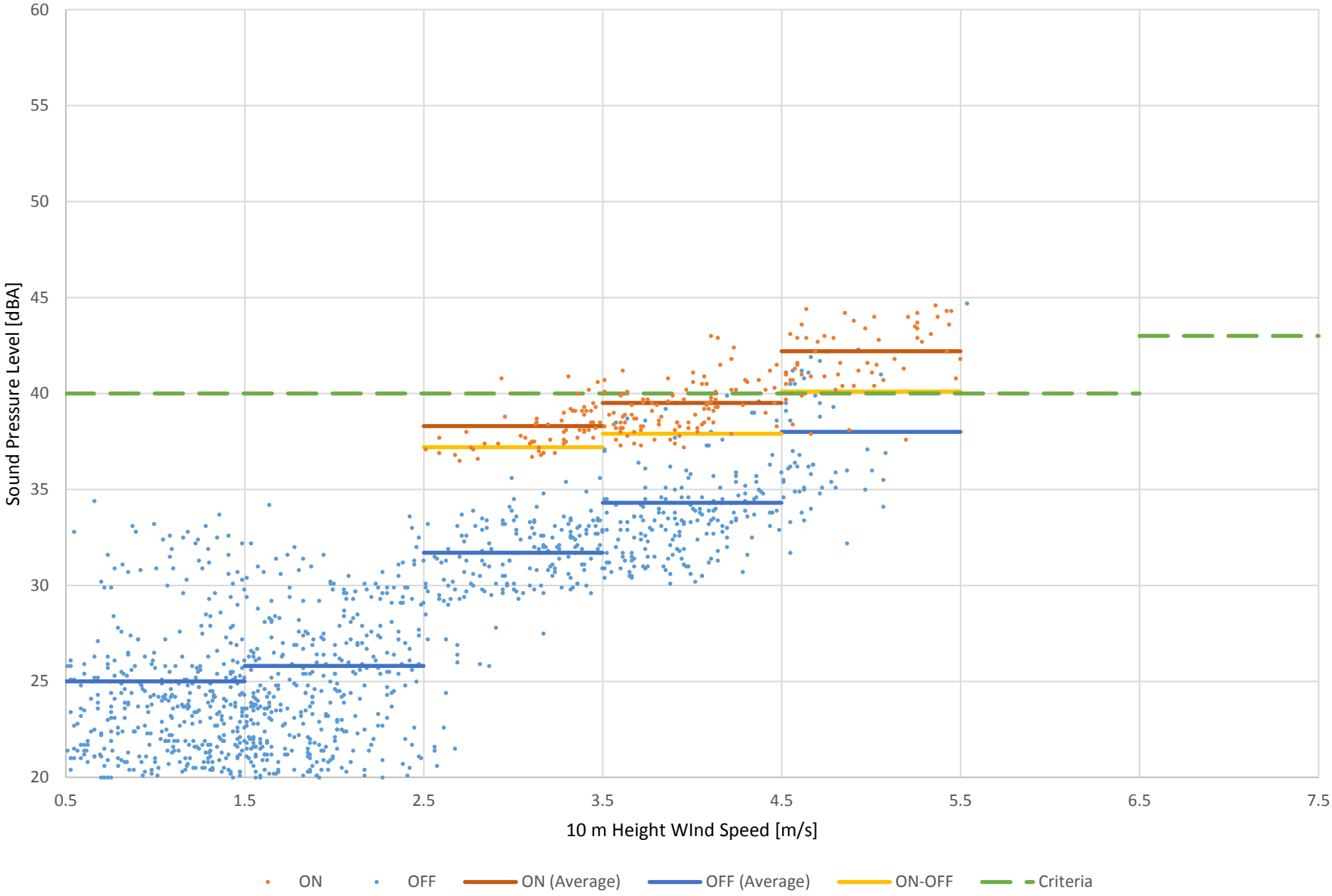
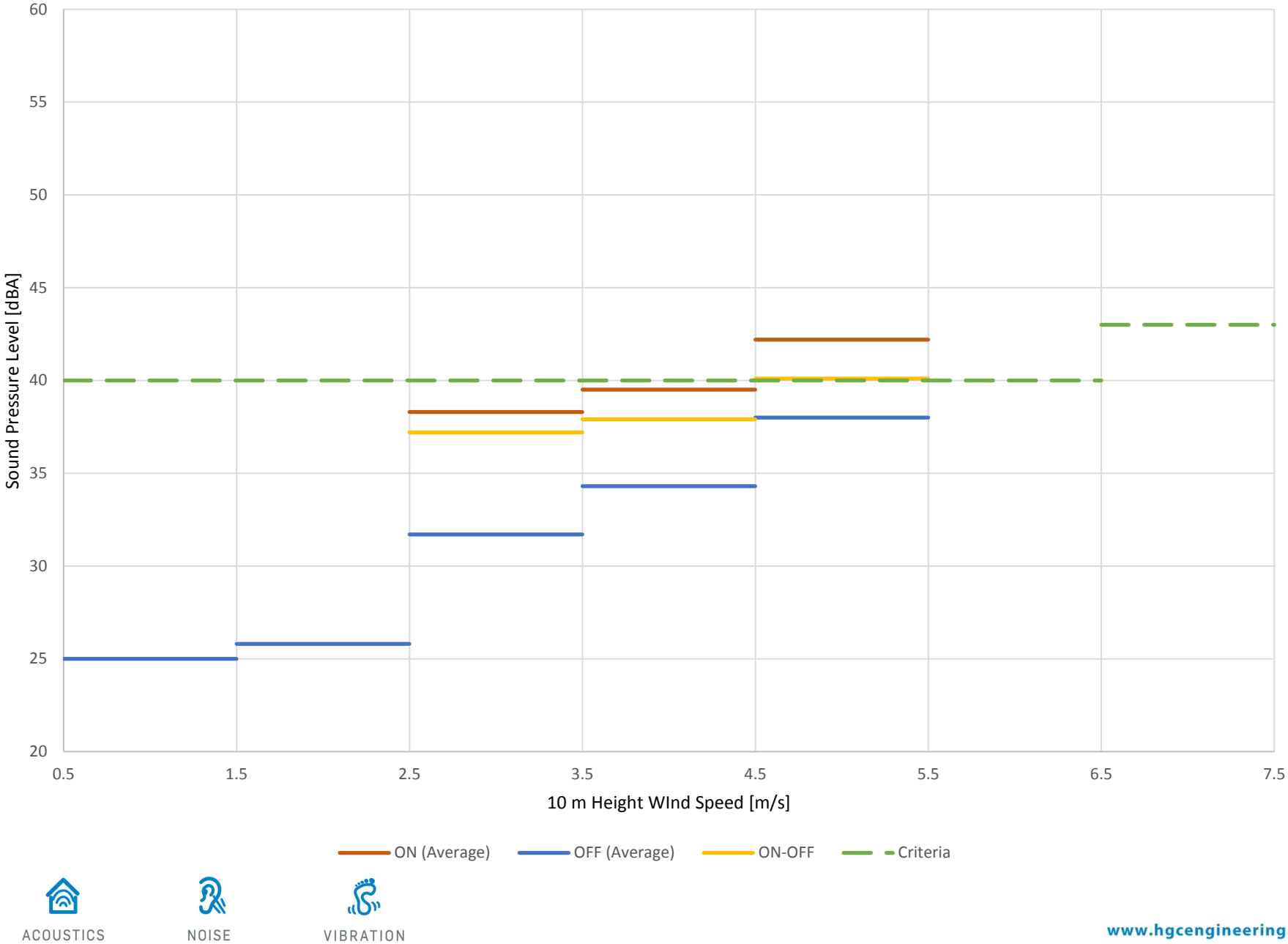


Figure 5b: McLean's Mountain Wind Project, Immission Results
Monitoring Location M2, March 28 to June 13, 2018



APPENDIX A:
MONITORING LOCATION SELECTION

Figure A1: Annual Wind Rose [8]

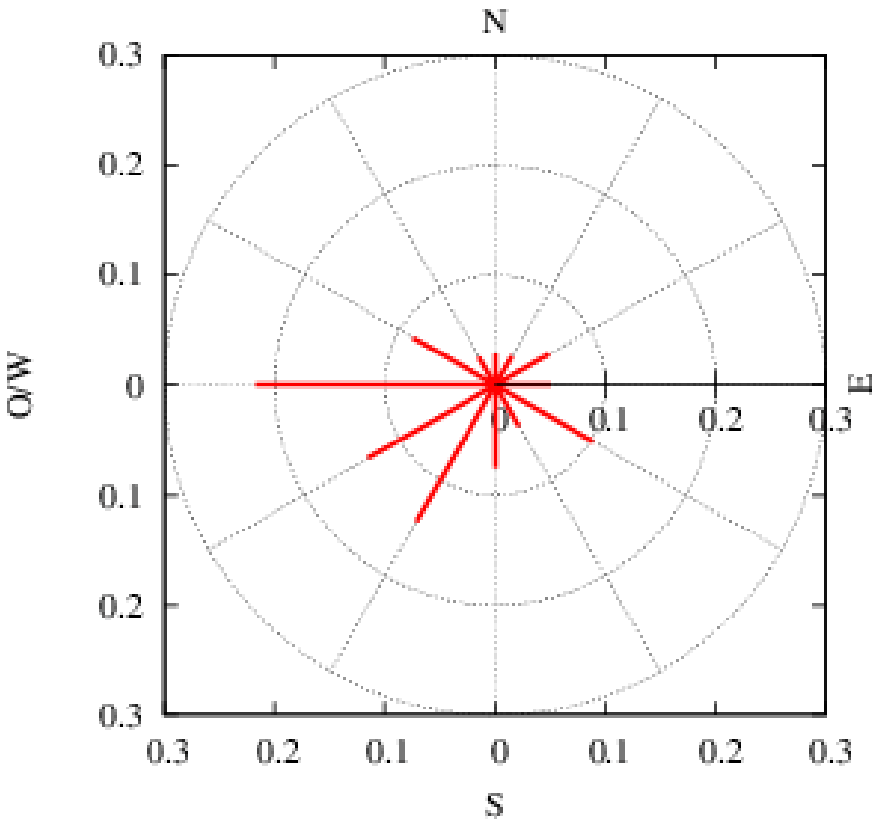


Table A1: Potential Receptor Locations

ID	Distance to nearest turbine [m]	Nearest turbine ID	Calculated Sound Pressure Level at Receptor [dBA] at selected Wind Speed in m/s					Suitable Audit Receptor	Comments
			6	7	8	9	10		
PR289	669	T11	38.8	38.8	38.8	38.8	38.8	Y	Used as alternate location for R282.
Monitoring Location M2	626	T11	38.4	38.4	38.4	38.4	38.4	Y	Selected Monitoring Location
R288	748	T20	38.4	38.4	38.4	38.4	38.4	N	Significant topographical change on property. V252 used as alternate location.
R281	632	T23	38.1	38.1	38.1	38.1	38.1	N	Not accessible.
V209	642	T36	38.1	38.1	38.1	38.1	38.1	N	Not accessible.
VP019	700	T09	38.0	38.0	38.0	38.0	38.0	Y	Selected Receptor
Monitoring Location M1	750	T09	38.1	38.1	38.1	38.1	38.1	Y	Selected Monitoring Location
V213	621	T35	37.9	37.9	37.9	37.9	37.9	N	Not accessible.
R282	889	T14	37.7	37.7	37.7	37.7	37.7	Y	No permission granted. PR289 used as alternate location.
V251	819	T20	37.7	37.7	37.7	37.7	37.7	N	Significant topographical change on adjacent property.
V241	664	T15	37.3	37.3	37.3	37.3	37.3	Y	Represented by V252.
V252	738	T19	37.3	37.3	37.3	37.3	37.3	Y	Immission Audit completed Spring 2015
V229	562	T17	37.1	37.1	37.1	37.1	37.1	Y	Represented by V252.
V208	832	T36	36.9	36.9	36.9	36.9	36.9	N	Not Accessible.
V240	660	T15	36.9	36.9	36.9	36.9	36.9	Y	Represented by V252.
R297	910	T20	36.8	36.8	36.8	36.8	36.8	N	Significant topographical change on property.
V256	819	T11	36.8	36.8	36.8	36.8	36.8	Y	Represented by PR289.
V216	867	T38	36.7	36.7	36.7	36.7	36.7	N	Not Accessible.
V235	719	T11	36.7	36.7	36.7	36.7	36.7	Y	Represented by PR289.
V254	695	T06	36.6	36.6	36.6	36.6	36.6	N	Not Accessible.
V215	796	T35	36.5	36.5	36.5	36.5	36.5	N	Not Accessible.
V244	706	T28	36.5	36.5	36.5	36.5	36.5	N	Not Accessible.
R296	822	T18	36.4	36.4	36.4	36.4	36.4	N	Not Prevailing Wind Direction.
V245	699	T28	36.4	36.4	36.4	36.4	36.4	N	Not Accessible.
R290	895	T11	36.2	36.2	36.2	36.2	36.2	Y	Represented by PR289.
R291	716	T11	36.1	36.1	36.1	36.1	36.1	Y	Represented by PR289.

± Sound levels taken from ENIA [2]

* Sound level predicted by acoustic model prepared by HGC Engineering

APPENDIX B:

MONITORING LOCATION PHOTOS

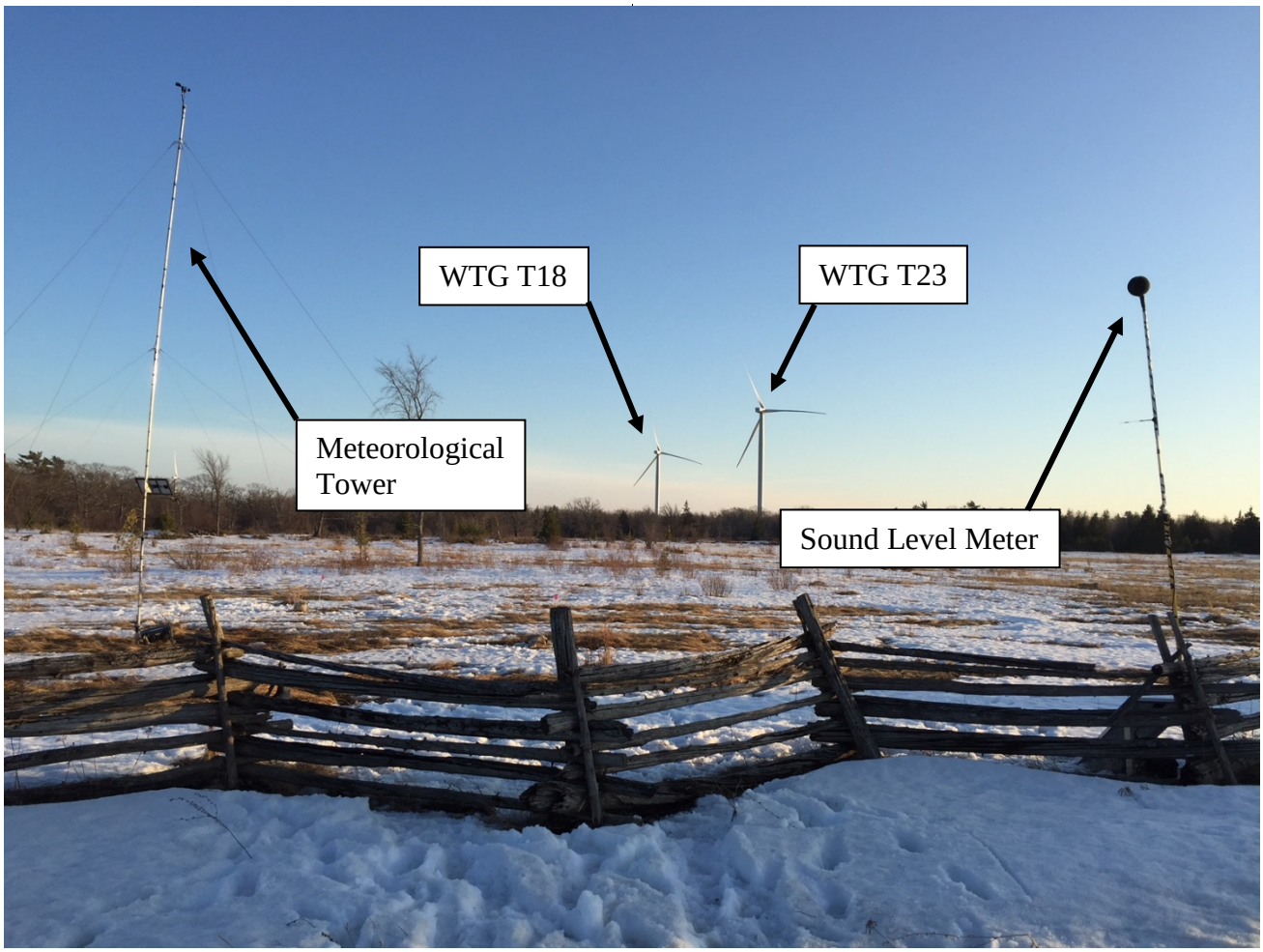


Photo of Meteorological Tower and Sound Level Meter at Location M2 (looking south)

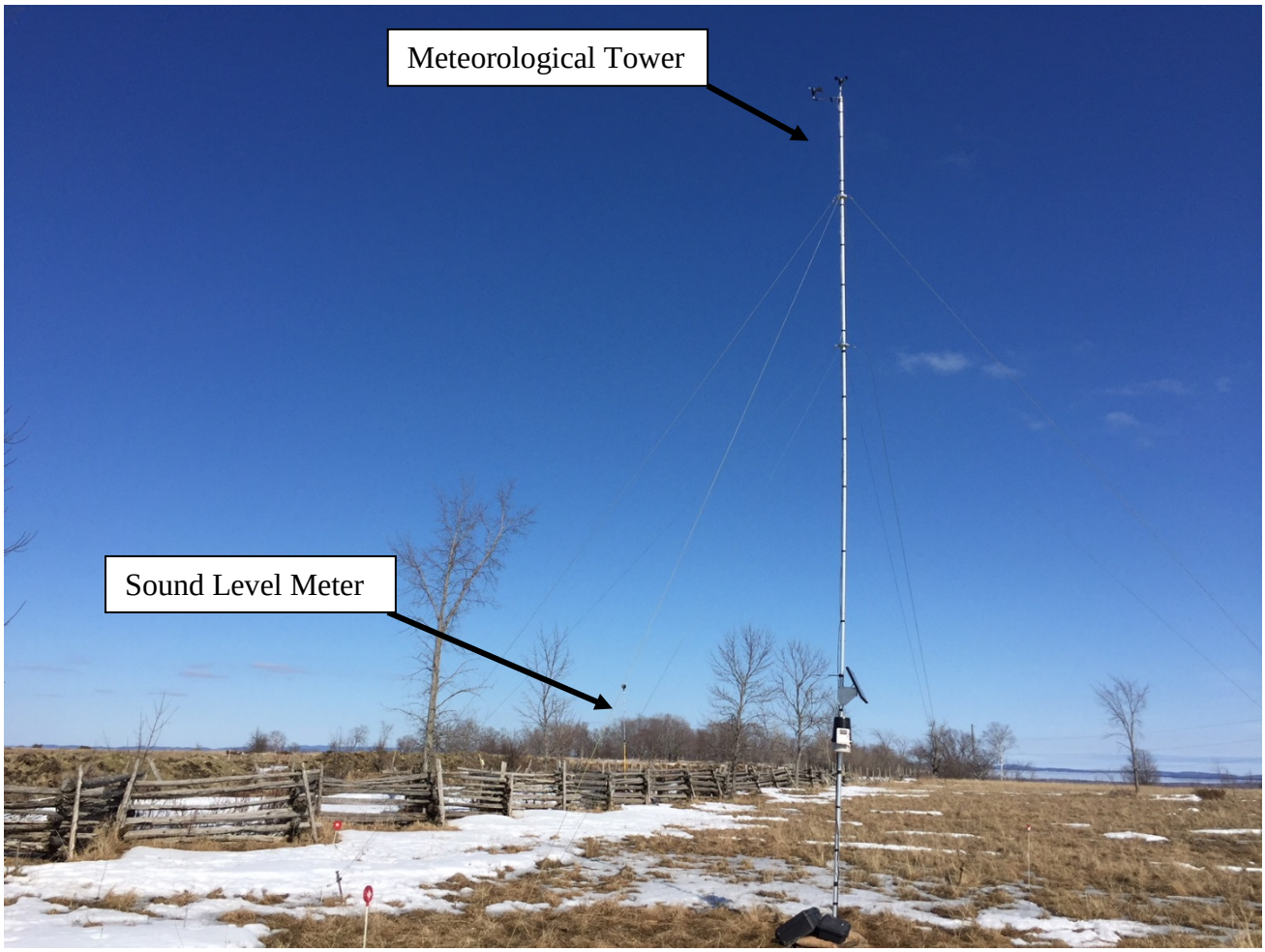


Photo of Meteorological Tower and Sound Level Meter at Location M1 (looking northeast)

APPENDIX C:
CALIBRATION CERTIFICATES

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

NRG

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Feb 9, 2017

NG

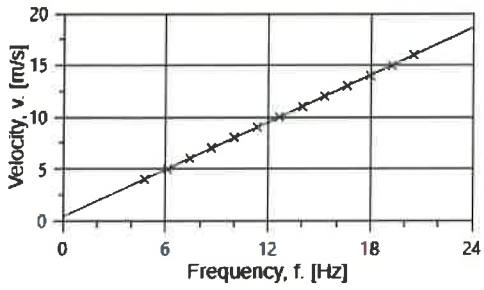
Certificate number: 17.US1.01492 **Date of issue:** February 06, 2017
Type: RNRG 40C Anemometer **Serial number:** 179500245122
Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada
Anemometer received: February 03, 2017 **Anemometer calibrated:** February 03, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

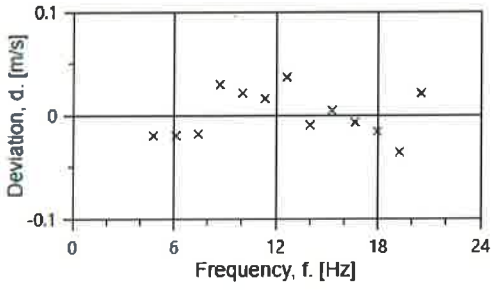
Calibration equation obtained: v [m/s] = 0.75982 · f [Hz] + 0.36149

Eric Jeffrey

Standard uncertainty, slope: 0.00176 **Standard uncertainty, offset:** 0.05015
Covariance: -0.0000226 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999983
Absolute maximum deviation: 0.036 m/s at 9.995 m/s
Barometric pressure: 1005.2 hPa **Relative humidity:** 13.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.28	23.6	26.2	3.967	4.7721	-0.020	0.025
4	14.59	23.7	26.2	4.977	6.1003	-0.020	0.025
6	21.09	23.6	26.2	5.983	7.4226	-0.018	0.027
8	28.77	23.6	26.2	6.988	8.6826	0.029	0.030
10	37.62	23.6	26.2	7.990	10.0125	0.021	0.033
12	47.70	23.6	26.2	8.998	11.3456	0.016	0.036
13-last	58.86	23.6	26.2	9.995	12.6302	0.036	0.038
11	71.06	23.6	26.2	10.982	13.9912	-0.010	0.041
9	84.58	23.6	26.2	11.982	15.2886	0.004	0.045
7	99.34	23.6	26.2	12.986	16.6247	-0.007	0.048
5	115.26	23.6	26.2	13.989	17.9557	-0.016	0.051
3	131.54	23.6	26.2	14.944	19.2398	-0.036	0.054
1-first	150.04	23.6	26.2	15.960	20.5026	0.021	0.057





AC-1746

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

NRG8
#6
Feb 9 2017

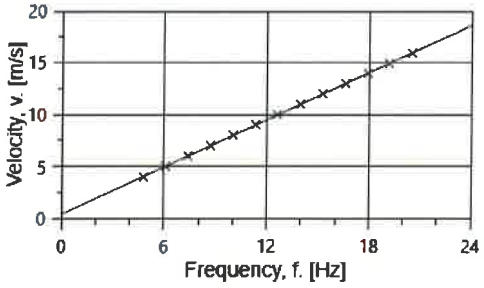
CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

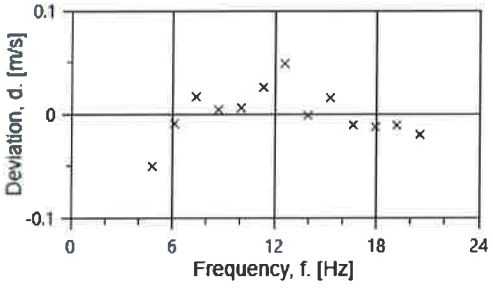
Certificate number: 17.US1.01491 **Date of issue:** February 06, 2017
Type: RNRG 40C Anemometer **Serial number:** 179500244813
Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada
Anemometer received: February 03, 2017 **Anemometer calibrated:** February 03, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.75963 · f [Hz] + 0.36998

Standard uncertainty, slope: 0.00188 **Standard uncertainty, offset:** 0.05239
Covariance: -0.0000258 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999981
Absolute maximum deviation: -0.050 m/s at 3.971 m/s
Barometric pressure: 1005.2 hPa **Relative humidity:** 13.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.29	23.6	26.2	3.971	4.8065	-0.050	0.025
4	14.68	23.6	26.2	4.991	6.0955	-0.009	0.026
6	21.15	23.6	26.2	5.991	7.3783	0.017	0.027
8	28.76	23.6	26.2	6.986	8.7045	0.004	0.030
10	37.64	23.6	26.2	7.992	10.0257	0.006	0.033
12	47.76	23.6	26.2	9.003	11.3304	0.026	0.036
13-last	58.77	23.6	26.2	9.987	12.5955	0.049	0.038
11	71.00	23.6	26.2	10.977	13.9650	-0.001	0.041
9	84.65	23.6	26.2	11.987	15.2722	0.016	0.045
7	99.35	23.6	26.2	12.987	16.6232	-0.011	0.048
5	115.18	23.6	26.2	13.984	17.9385	-0.013	0.051
3	131.29	23.6	26.2	14.929	19.1810	-0.011	0.054
1-first	149.62	23.6	26.2	15.937	20.5190	-0.020	0.057





AC-1746

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 45419

Asset # : SV977-7

Reference # : 151328

Customer : HGC Engineering
Mississauga, ON

P. Order : MG
18 Jan 2018

Cal. status : Received in spec's, no adjustment made.

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Jan 15, 2018

Cal. Due : Jan 15, 2019

By : T. Beilin

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 45420

Asset # : SV977-8

Reference # : 151330

Customer : HGC Engineering
Mississauga, ON

P. Order :

Cal. status : Received in spec's, no adjustment made.

16 Jan 2018

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Jan 15, 2018

Cal. Due : Jan 15, 2019

By : T. Beilin

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

APPENDIX D:

MODIFIED POWER FILTER CALCULATIONS

Power Curve - GE 2.49 MW	
Wind speed [m/s]	Power [kW]
0	0
1	0
2	0
3	2
4	86
5	263
6	499
7	824
8	1231
9	1652
10	2031
11	2292
12	2432
13	2489
14	2490
15	2490
16	2490
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18	2490
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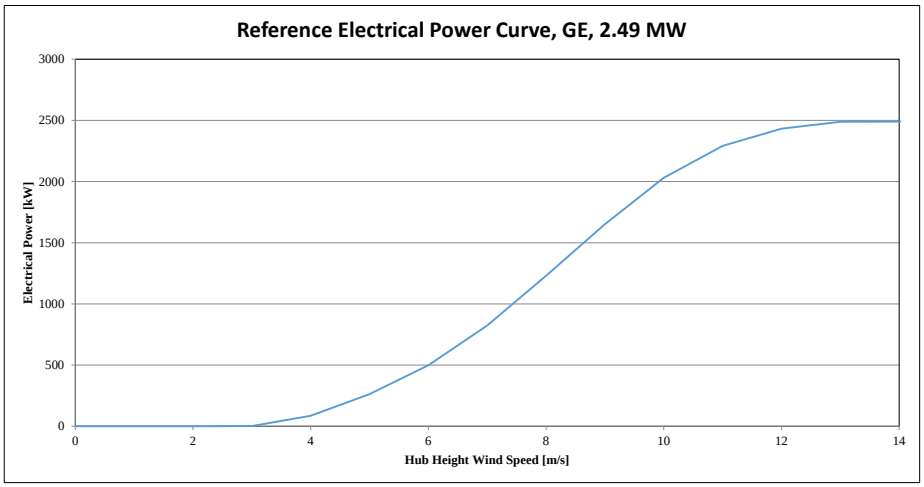
21	2490
22	2490
23	2490
24	2490
25	2490



Manufacturer's Data [GE]								
Max. Power 2490 kW	92.4	93.2	97.6	102.6	103	103	103	103
10m Height Wind speed [m/s]	3	4	5	6	7	8	9	10

90% sound energy [dBA]	102.5		
10m wind speed at 90% PWL [m/s]	97.6	5	
	102.5	5.99	<-- Using Linear Regression
	102.6	6	
Roughness length, z0 [m]	0.05		
Hub height [m]	98		
Reference height [m]	10		
Hub height wind speed at 90% PWL [m/s]	8.6		
Power [kW]	8	1231	
	8.6	1470	<-- Using Linear Regression
	9	1652	

Calculated Power output at 90% rated PWL [kW]	1470	Modified power filter used in the analysis	1700

Power Curve - GE 2.66 MW	
Wind speed [m/s]	Power [kW]
0	0
1	0
2	0
3	2
4	86
5	263
6	499
7	824
8	1235
9	1719
10	2188
11	2511
12	2646
13	2646
14	2646
15	2646
16	2646
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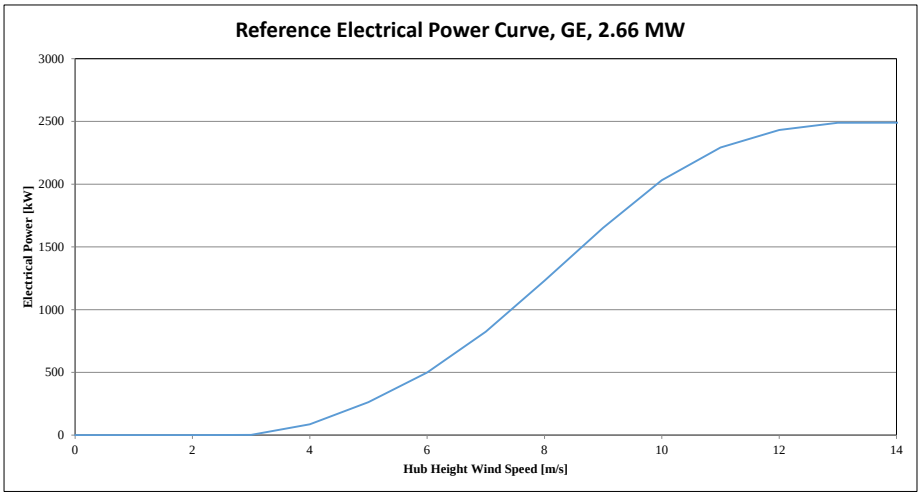
21	2646
22	2646
23	2646
24	2646
25	2646



Manufacturer's Data [GE]								
Max. Power 2490 kW	92.4	93.2	97.6	102.6	104	104	104	104
10m Height Wind speed [m/s]	3	4	5	6	7	8	9	10

90% sound energy [dBA]	103.5		
10m wind speed at 90% PWL [m/s]	102.6	6	
	103.5	6.67	<-- Using Linear Regression
	104	7	
Roughness length, z0 [m]	0.05		
Hub height [m]	98		
Reference height [m]	10		
Hub height wind speed at 90% PWL [m/s]	9.5		
Power [kW]	9	1652	
	9.5	1860	<-- Using Linear Regression
	10	2031	

Calculated Power output at 90% rated PWL [kW]	1860	Modified power filter used in the analysis	2000

APPENDIX E:

STATEMENT OF OPERATION

NORTHLAND POWER

McLean's Mountain Wind Farm

July 23, 2018

Re: Statement of Operation
McLean's Mountain Wind Project
Manitoulin Island, Ontario

To whom it may concern,

This letter is to confirm that the wind turbine generators at the McLean's Mountain Wind Farm were operating normally between March 28 and June 13, 2018. Additionally, this letter confirms that the relevant turbines were shut down for ambient (OFF) condition measurements.

Albert Willis

Yours Truly,

Albert Willis
Site General Manager
McLean's Mountain Wind Farm

P.O Box 73, 1192 Green Bush Road, Little Current, Ontario, Canada. P0P 1K0 t: 705.368.0303 f: 705.368.0606